

In the Specification

Please replace pages 4-8 of the specification as originally filed with the following text on pages 2-8 of this amendment:

and this relatively rigid area during installation. The inside diameter of the c-shaped portion is desirably extended axially towards the end of the c-shaped portion and towards a first end of the seal, and slightly inwardly, desirably terminating in a small inwardly curled portion forming a lip. The opposed portion of the c-shaped portion connects to a longitudinally extending portion which extends above or beyond the c-shaped portion and which desirably terminates in a small outwardly curved portion. The overall configuration of the seal is somewhat L-shaped, or J-shaped.

In a related aspect, the present invention is directed to an annular seal member having a generally "j" shaped cross-section and comprising a first end portion having a first distal end, a generally curled second end portion that extends to a second distal end, and a central body portion between and contiguous with the first and second end portions. The annular seal member has a first side and an opposite second side. The second end portion curls in a first direction in accordance with a predetermined radius such that the second distal end is located across from the first side of the seal member and the first and second distal ends do not face each other.

In another aspect, the present invention is directed to an annular seal member comprising a first side and an opposite second side, a generally frustoconical central body portion having opposite ends, a first end portion contiguous with one of the opposite ends of the generally frustro-conical central body portion, and a generally curled second end portion contiguous with the other of the opposite ends of the generally frustro-conical central body

portion. The first end portion has a first distal end. The second end portion extends to a second distal end. The second end portion curls in a first direction in accordance with a predetermined radius such that the second distal end is located across from the first side of the annular seal member and the first and second distal ends do not face each other.

In a further aspect, the present invention is directed to an annular seal member having a generally hook shaped cross-section, a first side and a second opposite side. The annular seal member comprises a first end portion having a first distal end, a generally curled second end portion that extends to a second distal end, and a central body portion between and contiguous with the first and second end portions. The second portion curls in a first direction in accordance with a predetermined radius such that the second distal end is located across from the first side of the annular seal member and the first and second distal ends do not face each other.

In another aspect, the present invention is directed to an annular metallic seal comprising a first side and an opposite second side, a generally frustro-conical central body portion having opposite ends, a first end portion contiguous with one of the opposite ends of the generally frustro-conical central body portion, and a curled second end portion contiguous with the other of the opposite ends of the generally frustro-conical central body portion. The first end portion has a first distal end. The second end portion extends to a second distal end. The generally frustro-conical central body has a thickness that tapers in the direction of the first distal end. The first distal end is slightly angulated in a first direction. The second end portion curls in the first direction in accordance with a predetermined radius such that the second distal end is located across from the first side of the annular metallic seal and the first and second distal ends do not face each other.

Further features and advantages of the present invention will appear herein below.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more readily understandable from a consideration of the accompanying drawings, wherein:

~~Figure 1 is an enlarged cross sectional view of a prior art axial c-seal;~~

Figure 1A is a side view, in longitudinal section, of a prior art axial c-seal;

Figure 1B is a enlarged view of a portion of the view shown in FIG. 1A;

Figure 2A is plan view of the annular seal member of the present invention;

Figure 2B is a side view, in longitudinal section, taken along line 2B-2B in Figure 2A;

Figure 2C is an enlarged view of the portion of the view shown in Figure 2B;

~~Figure 2 2D is a is an enlarged cross-sectional view of one embodiment of the seal of the present invention;~~

Figure 2E is another plan view of the seal of the present invention;

Figure 2F is a side view, in longitudinal section, taken along line 2F-2F in Figure 2E;

Figure 2G is an enlarged view of a portion of the view shown in Figure 2F;

~~Figure 3 is an enlarged a side view, in longitudinal section, of a further embodiment of the seal of the present invention;~~

~~Figure 4 is an enlarged a schematic cross-sectional view of the installation of the seal of the present invention;~~

Figure 5 is ~~an enlarged~~ a schematic cross-sectional view of a seal of the present invention installed, with an ~~the~~ axis of a ~~the~~ probe displaced to the right;

Figure 6 is ~~an enlarged~~ a schematic cross-sectional view of installed seal of the present invention with the axis of the probe displaced to the left; and

Figure 7 is ~~an enlarged~~ a schematic cross-sectional view of an installed seal of the present invention at operating pressure.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings in detail, ~~Figure 1~~ Figures 1A and 1B show ~~shows an enlarged end view~~ views of a prior art axial c-seal 10, showing an arcuate portion 12, outer sealing line 14 and inner sealing line 16.

Referring to Figures 2A-2G, there are shown various views of the seal 20 of the present invention. Figure 2 shows an enlarged end view of one embodiment of a seal 20 of the present invention showing Seal 20 comprises an arcuate portion 22, outer sealing line 24 and inner sealing line 26. In addition, the seal 20 of Figure 2 Seal 20 includes an inward curl 28 at one end of the arcuate portion which forms a return 29 at a first edge 30 of seal 20, and the opposed end of the arcuate portion connects to an inwardly tapering frustro-conical portion or longitudinally extended portion 32 which terminates in an outward curved portion 34 to the second opposed edge 36 of seal 20. The function of the return 29 is to provide stiffening and a lead-in which facilitates assembly for the smooth insertion of the seal into the an external cavity during installation.

Figure 2C is an enlarged view of the portion of the view of Figure 2B indicated by the dashed circle. Similarly, Figure 2G is an enlarged view of the portion of the view of Figure 2F indicated by the dashed circle.

Figure 3 shows ~~an enlarged~~ a side view of a further embodiment of the present invention. ~~seal 40 of the present invention showing the~~ Seal 40 comprises arcuate portion 42, an inwardly tapered frustro-conical portion 44, inward curl 46 and outward curl 48. A first portion 50 is connected to a second portion 52 of seal 40 by longitudinally extending body portion 54, which depicts a preferred longitudinally extending body of the seals of the present invention. ~~The embodiment of the seal shown in Figure 3~~ Seal 40 further includes a material taper 56 at the frustro-conical portion 44 wherein the thickness of the material forming the seal 40 decreases to increase flexibility of the seal 40.

The preferred materials for the seals of the present invention include nickel super alloys and nickel cobalt alloys, although other metals may be used.

~~The seals~~ seal of the present invention have has several significant advantages. ~~Thus the~~ One advantage is that the flexibility of the inward facing lip 29 is enhanced by increased distance from the more rigid c-shaped part of the section and it can be deflected radially by a lower force.

~~In addition,~~ Another advantage is that the configuration of the frustro-conical portion 44 may be reshaped by deflecting relatively easily to accommodate an off-center probe without plastic deformation of this region.

~~Still further, the~~ A further advantage is that the seal of the present invention may be manufactured from a relatively thicker material stock ~~from that of~~ in comparison to the prior art axial-c-seal ~~if desired~~ without an appreciable increase in insertion force or galling tendencies.

~~In addition,~~ Another advantage is that when the seal of the present invention is manufactured from relatively thicker material, in comparison to the prior art axial c-seal, the greater material thickness and a close proximity between the installed probe and the deflected

inner frustro-conical leg of the ring cross-section ~~enables~~ allow for higher operating and proof pressures to be sustained without gross permanent deformation.

A further advantage of the seal of the present invention is enhanced reliability. ~~Also, the seals of the present invention have enhanced reliability.~~ Multiple insertions of the probe into prior art seals have been a problem for prior art seals.

~~A further~~ Another advantage of the ~~seals~~ seal of the present invention results from the is-a tapered cross-section of the frustro-conical portion. This ~~even more~~ flexible feature is advantageous for dynamic, sliding application, albeit at slow speeds, because of reduction of contact stresses.

Referring to Figure 4, is-an-enlarged, ~~schematic side view of~~ there is illustrated the installation of a seal ~~the seals of the present invention showing the insertion of a the~~ aforsaid seal of the present invention in the body of a coupling. ~~Figure 4 shows seal~~ Seal 60 is installed in body 62 of a coupling, with retaining wall 64 positioned adjacent the seal and probe 66 spaced from the seal. Referring to Figure 5, there is shown seal 70 in accordance with another embodiment of the present invention. Seal 70 comprises ~~shows an alternate seal 70~~ having an outward curved portion 72 and frustro-conical portion 74. The seal 70 is installed in an interference relationship with body 62 and axial retaining wall 64, with probe 66 inserted in contacting, interfering relationship with the seal adjacent to the frustro-conical portion 74. Elastic deflection of the seal inner lip and tapered frustro-conical portion 74 permits lateral offset of the probe without leakage. ~~In Figure 5 the~~ The axis of probe 66 is displaced to the right vis-à-vis body 62, ~~whereas the embodiment of~~ Referring to Figure 6, there is shown ~~shows~~ a relationship similar to that shown in Figure 5. However, and depicts the axis of the probe is displaced to the left vis-à-vis body 62, widening the gap between body 62 and the frustro-conical portion 74.

Figure 7 ~~shows an enlarged schematic side is a~~
~~view of an installed seal, similar to the view~~
~~shown in Figure 5. of similar to Figure 5 of an~~
~~installed seal 60~~ However, Figure 7 shows seal
60 at exemplicative high operating pressure of
30,000 psi deflecting the walls of the seal
wherein the seal 60 is not completely deformed.
The darker areas 80 on the body 62, retaining
wall 64 and probe 66 show higher stress contact
regions.

Naturally, variations in the seal are
contemplated. For example, the longitudinally
extending portion could be conical or have a
slight curve. The c-shaped portion could have
variations and flats and need not be uniform.
All shapes could be slightly irregular.

Various coatings, including silver or gold, may
be beneficially applied to the seal or its
contact surfaces in order to improve its
sealing efficiency. For dynamic applications,
special anti-galling, low-friction coatings may
be applied. Thus, sealing contact areas may be
coated with soft, lubricious and/or anti-
galling materials.

It is to be understood that the invention is
not limited to the illustrations described and
shown herein, which are deemed to be merely
illustrative of the best modes of carrying out
the invention, and which are susceptible of
modification of form, size, and arrangement of
parts and details of operation. Rather, The
the invention rather is intended to encompass
all such modifications which are within the
spirit and scope as defined by the claims.